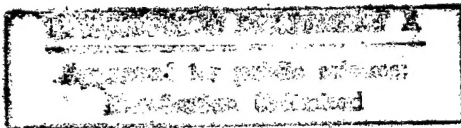


FINAL REPORT  
NOVEMBER 1997

REPORT NO. 96-36

BARNES & REINECKE, INC. (BRI)  
PALLETIZED LOADING  
SYSTEM (PLS) FLATRACK  
TRANSPORTABILITY TESTING

19980929 004



Prepared for:  
U.S. Army Tank-automotive  
and Armaments Command  
ATTN: SFAE-CS-TVH  
Warren, MI 48397-5000

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| <p>The U.S. Army Defense Ammunition Center (DAC), Validation Engineering Division (SIOAC-DEV), was tasked by U.S. Army Tank-automotive and Armament Command (TACOM) to evaluate the Barnes &amp; Reinecke, Inc. (BRI) version of a flatrack that would be compatible with the Palletized Loading System (PLS) and as a possible second source for new flatracks. The Model FS-2 flatrack supplied by BRI was fabricated by Sea Containers Services Ltd. The FS-2 flatrack has a tare weight of 6,878 pounds and an International Organization for Standardization (ISO) payload of 67,190 pounds.</p> <p>The flatrack was loaded with 155MM Separate Loading Projectiles (SLPs) and boxed ammunition simulating the maximum PLS payload. It was subjected to rail impact tests at 4, 6, and 8.1 mph and 8.1 mph in reverse in, two rail transportation modes and to the road test transportation environment. The transportation modes were Trailer-on-flatcar (TOFC) and cabled to a regular flatcar with 5/8-inch cables.</p> |       |   |   |  |                                 |
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VALIDATION ENGINEERING DIVISION  
SAVANNA, IL 61074-9639

REPORT NO. 96-36

BARNES & REINECKE, INC. (BRI) PALLETIZED LOADING SYSTEM (PLS)  
FLATRACK TRANSPORTABILITY TESTING

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## PART 1

### INTRODUCTION

A. **BACKGROUND.** The U.S. Army Defense Ammunition Center (DAC), Validation Engineering Division (SIOAC-DEV), was tasked by U.S. Army Tank-automotive and Armaments Command (TACOM) to evaluate the Barnes & Reinecke, Inc. (BRI) version of a flatrack that would be compatible with the Palletized Loading System (PLS) and as a possible second source for new flatracks. The Model FS-2 flatrack supplied by BRI was fabricated by Sea Containers Services Ltd. The FS-2 flatrack has a tare weight of 6,878 pounds and an International Organization for Standardization (ISO) payload of 67,190 pounds. This flatrack was tested to the most severe transportation environment, namely movement by railcar, to the test criteria specified in Transportability Testing Procedures, TP-94-01, July 1994.

B. **AUTHORITY.** This test was conducted IAW mission responsibilities delegated by the U.S. Army Armament, Munitions and Chemical Command (AMCCOM), Rock Island, IL 61299-6000. Reference is made to Change 4, 4 October 1974, to AR-740-1, 23 April 1971, Storage and Supply Operations; AMCCOM-R 10-17, 13 January 1986, Mission and Major Functions of USADACS.

C. **OBJECTIVE.** The flatrack was loaded with 155MM Separate Loading Projectiles (SLPs) and simulated boxed ammunition and was subjected to rail impact tests at 4, 6, and 8.1 mph and 8.1 mph in reverse in two rail transportation modes and road transportation tests. The transportation modes were Trailer-on-flatcar (TOFC) and cabled to a regular flatcar with 5/8-inch cables. The object of this evaluation was to determine if the end walls of the flatrack would spread beyond the ISO standard of 19-feet 10-inches to a point where it could not be lifted with a toplifting container handler.

D. CONCLUSION. No failures in the FS-2 flatrack were observed during the rail impact and road testing sequences for the two different loads. Careful attention was given to the spread in the flatrack end walls during rail impact testing. The worst-case spreading was 0.41-inch with the regulation PLS payload of 38,500 pounds. With the flatrack loaded to the maximum ISO capacity, the maximum spread was 0.68-inch beyond ISO limits. This amount of spread is not significant to prevent the FS-2 flatrack from being handled safely with toplifting equipment or with the PLS truck.

E. RECOMMENDATION. It is recommended that the FS-2 flatrack be considered as an alternate source for a deployable platform for use with the PLS.

## PART 2

6 - 8 MAY 1996

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## PART 3

### TEST PROCEDURES

A. These test procedures were extracted from TP-94-01, Transportability Testing Procedures, July 1994, for validating tactical vehicles and outloading procedures used for shipping munitions by intermodal freight containers, commercial or tactical truck, or trailer or railcar.

B. The FS-2 flatrack test load was prepared using the same blocking and bracing methods specified in the tiedown procedures proposed for use with munitions (see Part 6 for porcedures). The FS-2 flatracks used in these tests were inspected to ensure their adequacy for munitions transport. Items used to build the load were inert (nonexplosive). The weight and physical characteristics of the load configuration were identical to the live (explosive) ammunition provided for in the tiedown procedure; i.e., weights, physical dimensions, center of gravity (CG), materials, etc. The ammunition packages duplicated that of the live ammunition.

C. Tests conducted for these loads were as follows:

1. Rail Impact - TOFC (Test Method No. 1).
2. Rail Impact - Flatcar (Test Method No. 1).
3. Hazard Course (Test Method No. 2).
4. Road Trip (Test Method No. 3).
5. Washboard Course (Test Method No. 6).

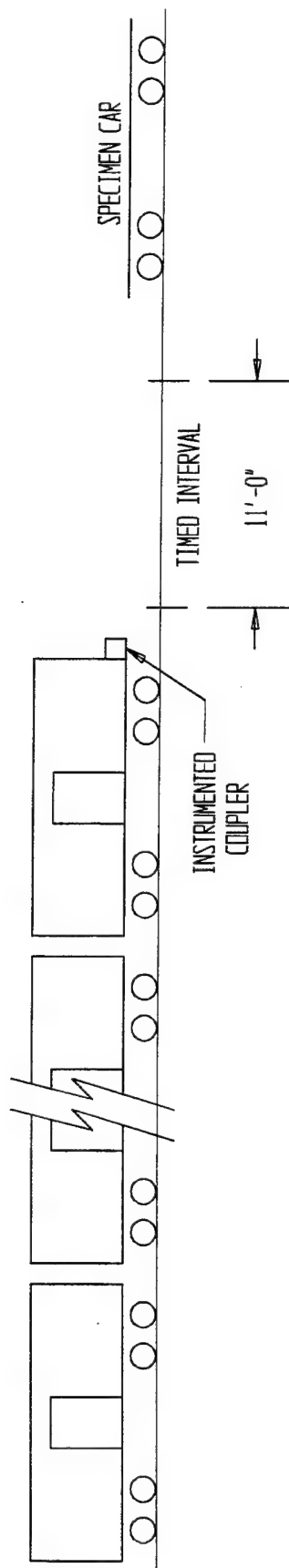
D. The test methods are as follows:

1. Test Method No. 1. The loaded FS-2 flatrack was placed onto a container chassis secured to a TOFC and secured to a conventional friction draft gear flatcar. Equipment needed to perform the test included the specimen (hammer) car, five empty railroad cars connected together to serve as an anvil, and a railroad locomotive. These anvil cars were positioned on a level section of track with air and hand brakes set and with draft gears compressed. The locomotive unit pulled the specimen car several hundred yards away from the anvil cars, and then, pushed the specimen car toward the anvil at a predetermined speed, then disconnected from the specimen car approximately 50 yards away from the anvil cars which allowed the specimen car to roll freely along the track until it struck the anvil. This constituted an impact. Impacting was accomplished at speeds of 4, 6, and 8.1 mph in one direction and at a speed of 8.1 mph in the reverse direction. The 4 and 6 mph impact speeds were approximate; the 8.1 mph speed was minimum. Impact speeds were determined by using an electronic counter to measure the time for the specimen car to traverse an 11-foot distance immediately prior to contact with the anvil cars (see Figure 1).

2. Test Method No. 2 - (Hazard Course). This step required the loaded FS-2 flatrack to be transported over the 200-foot-long segment of concrete-paved road which consisted of two series of railroad ties projecting 6 inches above the level of the road surface. The loaded FS-2 flatrack traversed this course two times.

3. Test Method No. 3 - (Road Trip). The loaded FS-2 flatrack was transported for a distance of 30 miles over a combination of roads surfaced with gravel, concrete, or asphalt. The test route included curves, corners, railroad crossings, cattle guards, and stops and starts. The FS-2 flatrack traveled at the maximum speed for the particular road being traversed, except as limited by legal restrictions. Upon completion of the 30-mile road trip, the loaded FS-2 flatrack was subjected to three full airbrake stops while traveling in the forward direction and one in the

# ASSOCIATION OF AMERICAN RAILROADS (AAR) STANDARD TEST PLAN



5 BUFFER CARS (ANVIL) WITH DRAFT GEAR  
COMPRESSED AND AIR BRAKES IN A SET  
POSITION

ANVIL CARS TOTAL WT 250,000 LBS (APPROX)

SPECIMEN CAR

IS RELEASED BY

SWITCH ENGINE TO

ATTAIN: IMPACT NO. 1 @ 4 MPH

IMPACT NO. 2 @ 6 MPH

IMPACT NO. 3 @ 8.1 MPH

THEN THE CAR IS REVERSED AND  
RELEASED BY SWITCH ENGINE TO

ATTAIN: IMPACT NO 4. @ 8.1 MPH

FIGURE 1

reverse direction. The first three stops were at 5, 10, and 15 mph, while the stop in the reverse direction was at approximately 5 mph.

4. Test Method No. 6 - (Washboard Course). The FS-2 flatrack was driven over the washboard course (Figure 2) at a speed which produced the most violent response in the FS-2 flatrack.

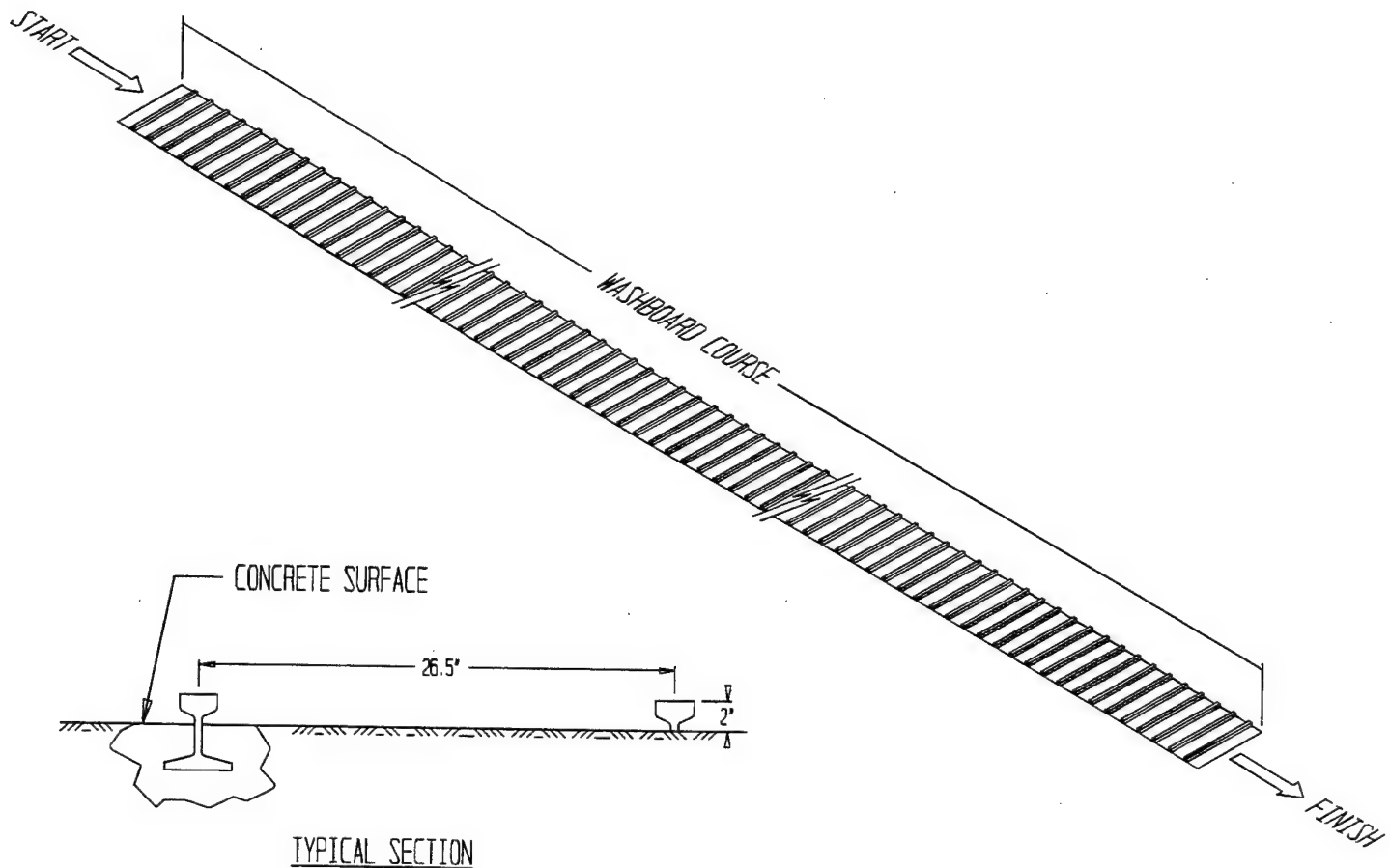


Figure 2

PART 4

TEST RESULTS

## RAIL IMPACT DATA

TEST NO.: 1

DATE: 6 May 1996

Specimen Load: FS-2 flatrack with 105MM boxed ammunition.

TOFC No.: TTWX 600585

Lt. Wt.: 80,500 pounds

Trailer Chassis: No. 4628

Wt.: 6,050 pounds

Container Type: FS-2 flatrack USAU 0115113

Wt: 6,878 pounds

Load Type: 105MM boxed ammunition

Wt.: 31,600 pounds

Total Specimen Wt.: 125,028 pounds

Buffer Car (five cars) Wt.: 250,000 pounds

| <u>IMPACT NO.</u> | <u>END STRUCK</u> | <u>VELOCITY</u><br>(mph) | <u>REMARKS</u>                     |
|-------------------|-------------------|--------------------------|------------------------------------|
| 1                 | Reverse           | 4.34                     | Load compacted<br>1 inch.          |
| 2                 | Reverse           | 6.46                     | No visible damage.                 |
| 3                 | Reverse           | 8.53                     | 3/4-inch gap at front.             |
| 4                 | Forward           | 8.10                     | 2-inch compression<br>gap at rear. |

## MEASURED END WALL SPREAD

| <u>MEASUREMENT</u> | <u>LEFT</u> | <u>ERROR</u> | <u>RIGHT</u> | <u>ERROR</u> |
|--------------------|-------------|--------------|--------------|--------------|
| START              | 238.89      | 0.01         | 238.78       | -0.10        |
| 1                  | 238.85      | -0.03        | 238.56       | -0.32        |
| 2                  | 238.98      | 0.10         | 238.74       | -0.14        |
| 3                  | 238.98      | 0.10         | 238.78       | -0.10        |
| 4                  | 239.29      | 0.41         | 239.17       | 0.29         |

### Notes:

1. The "START" measurement was made before any impacts. All other measurements were made after an impact.
2. The "ERROR" calculation is based on the difference between the maximum allowable distance of 238.88 inches for an ISO container.
3. The largest error is 0.41-inch, exceeding the accepted width by 0.17 percent which is not significant to cause unsafe handling problems of the loaded flatrack; i.e., toplifting and stowing.

## ROAD TEST DATA

TEST NO.: 2

DATE: 6 May 1996

Specimen Load: FS-2 flatrack with 105MM boxed ammunition.

### ROAD HAZARD COURSE:

|                                      |              |          |
|--------------------------------------|--------------|----------|
| PASS 1-A OVER FIRST SERIES OF TIES:  | 6.45 seconds | 5.28 mph |
| PASS 1-B OVER SECOND SERIES OF TIES: | 5.60 seconds | 5.85 mph |
| REMARKS: No lateral load movement.   |              |          |

|                                      |              |          |
|--------------------------------------|--------------|----------|
| PASS 2-A OVER FIRST SERIES OF TIES:  | 5.72 seconds | 5.96 mph |
| PASS 2-B OVER SECOND SERIES OF TIES: | 6.18 seconds | 5.29 mph |
| REMARKS: No lateral load movement.   |              |          |

30-MILE ROAD TEST: No damage or load movement observed after completion of the road test.

PANIC STOP TEST: No panic stops were performed since this load was previously rail impact tested.

|                                      |              |          |
|--------------------------------------|--------------|----------|
| PASS 3-A OVER FIRST SERIES OF TIES:  | 6.41 seconds | 5.32 mph |
| PASS 3-B OVER SECOND SERIES OF TIES: | 6.24 seconds | 5.24 mph |
| REMARKS: No lateral movement.        |              |          |

|                                      |              |          |
|--------------------------------------|--------------|----------|
| PASS 4-A OVER FIRST SERIES OF TIES:  | 6.31 seconds | 5.40 mph |
| PASS 4-B OVER SECOND SERIES OF TIES: | 5.62 seconds | 5.82 mph |
| REMARKS: No lateral movement.        |              |          |

WASHBOARD COURSE: No additional load movement.

## RAIL IMPACT DATA

TEST NO.: 3

DATE: 7 May 1996

Specimen Load: FS-2 flatrack with 105MM boxed ammunition.

Flat Car No.: BN615005

Lt. Wt.: 47,500 pounds

Container Type: FS-2 flatrack USAU 0115113

Wt.: 6,878 pounds

Load Type: 105 MM boxed ammunition

Wt.: 31,600 pounds

Total Specimen Wt.: 85,978 pounds

Buffer Car (five cars) Wt.: 250,000 pounds

| <u>IMPACT NO.</u> | <u>END STRUCK</u> | <u>VELOCITY</u><br>(mph) | <u>REMARKS</u>  |
|-------------------|-------------------|--------------------------|---|
| 1                 | Reverse           | 4.14                     | End wall lock<br>embedded into load.                                    |
| 2                 | Reverse           | 6.11                     | 1-inch gap at front<br>(bailbar) end.                                   |
| 3                 | Reverse           | 8.10                     | Load shifted, front,<br>1-1/2-inch at top<br>and 2-inches at bottom.    |
| 4                 | Forward           | 8.71                     | Load shifted to rear,<br>1-1/2-inches at top and<br>2-inches at bottom. |

## MEASURED END WALL SPREAD

| <u>MEASUREMENT</u> | <u>LEFT</u> | <u>ERROR</u> | <u>RIGHT</u> | <u>ERROR</u> |
|--------------------|-------------|--------------|--------------|--------------|
| START              | 238.56      | -0.32        | 238.56       | -0.32        |
| 1                  | 238.78      | -0.10        | 238.50       | -0.38        |
| 2                  | 238.94      | 0.06         | 238.70       | -0.18        |
| 3                  | 238.94      | 0.06         | 238.78       | -0.10        |
| 4                  | 239.09      | 0.21         | 239.09       | 0.21         |

### Notes:

1. The "START" measurement was made before any impacts. All other measurements were made after an impact.
2. The "ERROR" calculation is based on the difference between the maximum allowable distance of 238.88 inches for an ISO container.
3. The largest error is 0.21-inch, exceeding the accepted width by 0.09 percent which is not significant to cause unsafe handling problems of the loaded flatrack; i.e., toplifting and stowing.

## RAIL IMPACT DATA

TEST NO.: 4

DATE: 15 May 1996

Specimen Load: FS-2 flatrack with 155MM SLPs

Flat Car No.: BN615005

Lt. Wt. 47,500 pounds

Container Type: FS-2 flatrack USAU 0115113

Wt.: 6,878 pounds

Load Type: 155MM SLPs

Wt.: 54,888 pounds

Total Specimen Wt.: 109,266 pounds

Buffer Car (five cars) Wt.: 250,000 pounds

| <u>IMPACT NO.</u> | <u>END STRUCK</u> | <u>VELOCITY</u><br>(mph) | <u>REMARKS</u>  |
|-------------------|-------------------|--------------------------|---|
| 1                 | Forward           | 4.58                     | 1/2-inch gap at top rear of load.                                       |
| 2                 | Forward           | 6.37                     | 1/2-inch gap at top rear of load.                                       |
| 3                 | Forward           | 8.86                     | 3/4-inch gap at top and 1/2-inch gap at middle and bottom rear of load. |
| 4                 | Reverse           | 8.38                     | 1/2-inch gap at front.  |

## MEASURED END WALL SPREAD

| <u>MEASUREMENT</u> | <u>LEFT</u> | <u>ERROR</u> | <u>RIGHT</u> | <u>ERROR</u> |
|--------------------|-------------|--------------|--------------|--------------|
| START              | 238.88      | 0.0          | 238.94       | 0.06         |
| 1                  | 238.81      | -0.07        | 238.94       | 0.06         |
| 2                  | 238.88      | 0.0          | 239.06       | 0.18         |
| 3                  | 239.50      | 0.62         | 239.56       | 0.68         |
| 4                  | 239.50      | 0.62         | 239.50       | 0.62         |

### Notes:

1. The "START" measurement was made before any impacts. All other measurements were made after an impact.
2. The "ERROR" calculation is based on the difference between the maximum allowable distance of 238.88 inches for an ISO container.
3. The largest error is 0.68 inch, exceeding the accepted width by 0.29 percent which is not significant to cause unsafe handling problems of the loaded flatrack; i.e., toplifting and stowing.

## ROAD TEST DATA

TEST NO.: 5

DATE: 15 May 1996

Specimen Load: FS-2 flatrack with 155MM SLPs

### ROAD HAZARD COURSE:

PASS 1-A OVER FIRST SERIES OF TIES: 8.26 seconds 4.13 mph

PASS 1-B OVER SECOND SERIES OF TIES: 7.17 seconds 4.57 mph

REMARKS: No lateral load movement.

PASS 2-A OVER FIRST SERIES OF TIES: 7.32 seconds 4.66 mph

PASS 2-B OVER SECOND SERIES OF TIES: 7.92 seconds 4.13 mph

REMARKS: No lateral load movement.

30-MILE ROAD TEST: No damage or load movement observed after completion of the road test.

PANIC STOP TEST: No panic stops were performed since this load was previously rail impact tested.

PASS 3-A OVER FIRST SERIES OF TIES: 8.20 seconds 4.15 mph

PASS 3-B OVER SECOND SERIES OF TIES: 7.99 seconds 4.26 mph

REMARKS: No lateral movement.

PASS 4-A OVER FIRST SERIES OF TIES: 8.08 seconds 4.22 mph

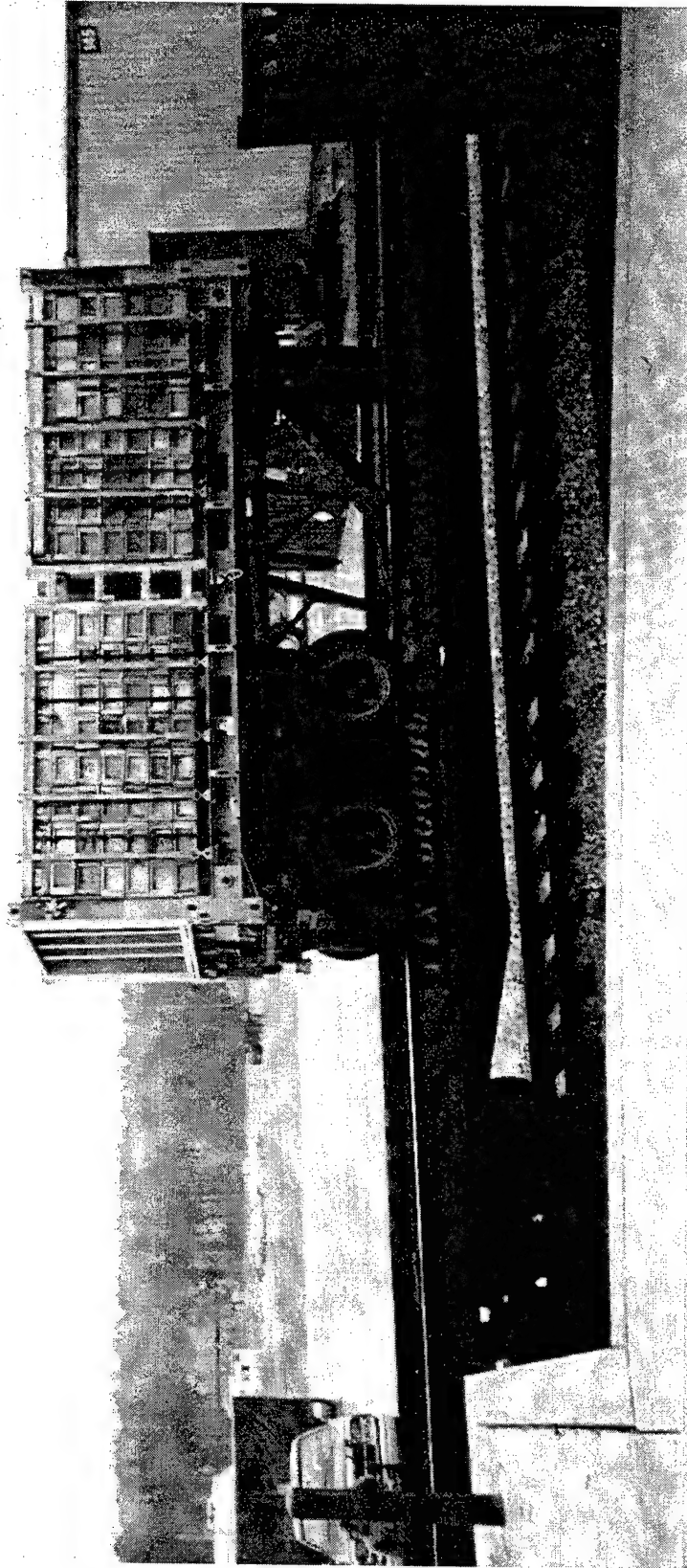
PASS 4-B OVER SECOND SERIES OF TIES: 7.20 seconds 4.55 mph

REMARKS: No lateral movement.

WASHBOARD COURSE: No additional load movement.

PART 5

PHOTOGRAPHS



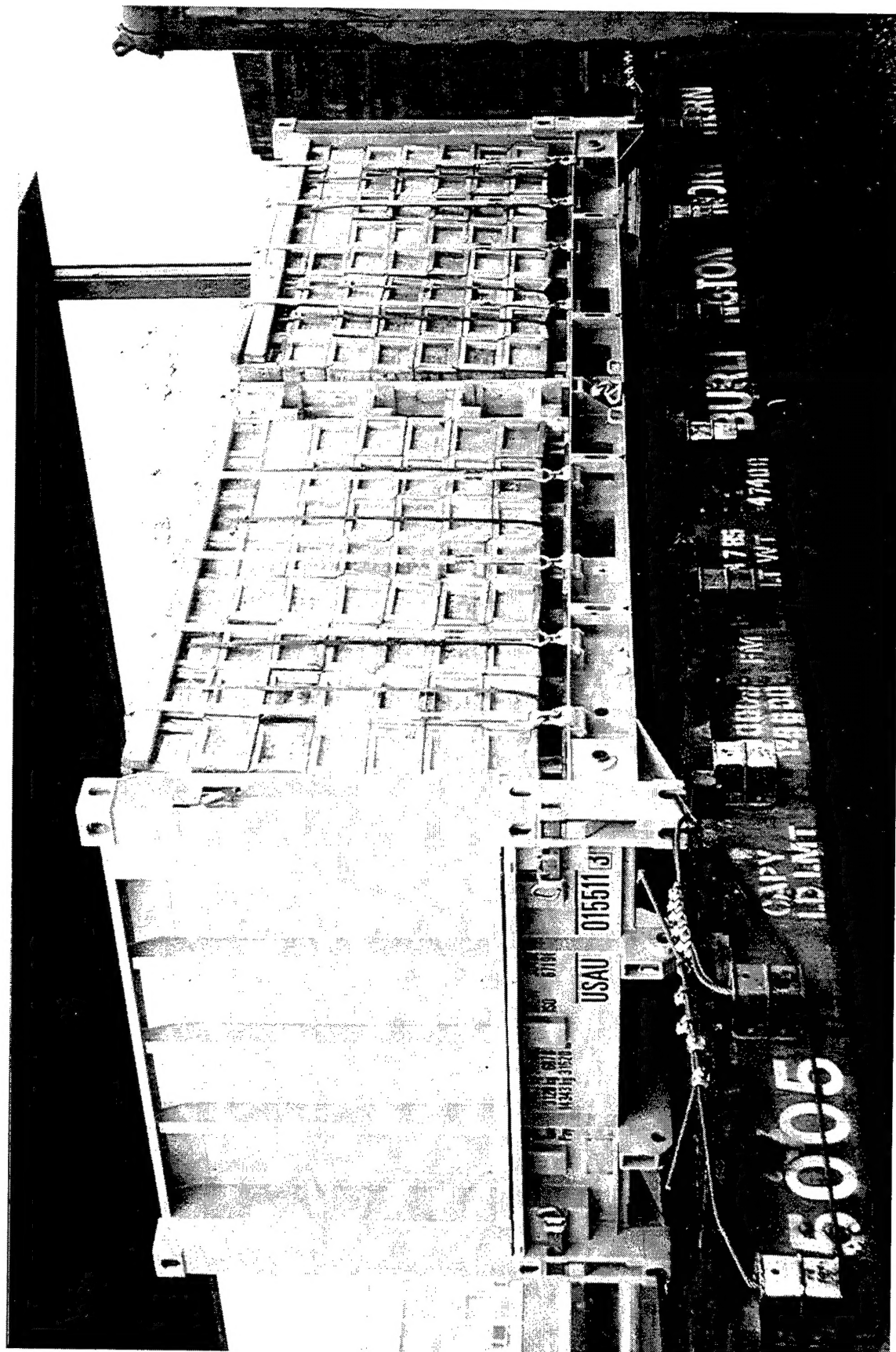
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Photo No. DAC-DEV-96-36-1. This photo shows the FS-2 flatrack with 105MM boxed ammunition loaded on a container chassis on a TOFC. The TOFC is positioned on the test track for rail impact tests with the rear of the trailer toward the buffer cars.



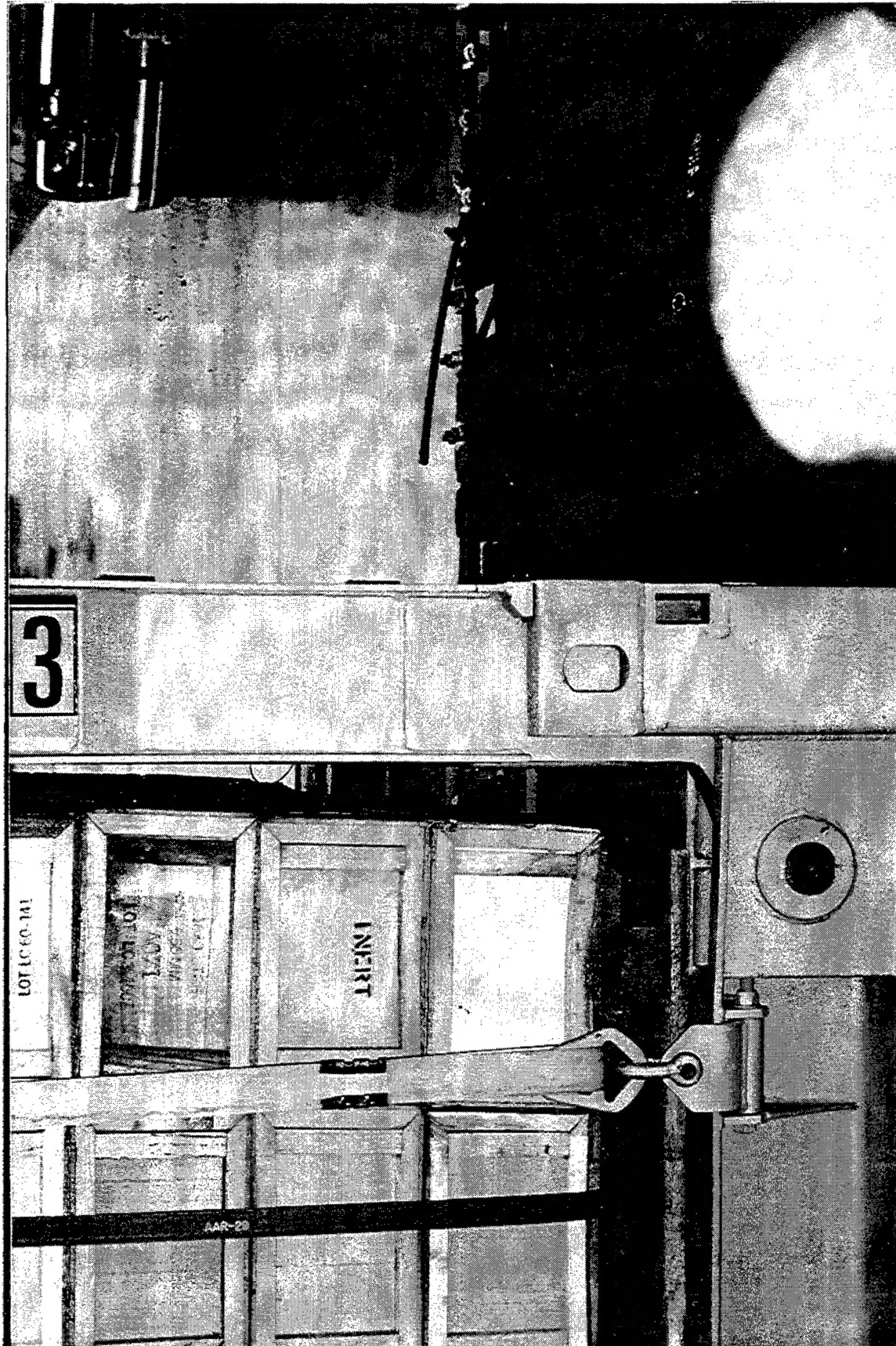
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SAVANNA, IL

Photo No. DAC-DEV-96-36-2. After rail impact testing, the loaded FS-2 flatrack was driven over the road hazard test track. The front and rear tires of the tractor can be seen rolling over the railroad ties that make up the test track. The trailer will follow over the ties, producing severe lateral movement in the flatrack.



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Photo No. DAC-DEV-96-36-3. In addition to testing the FS-2 flatrack in conventional transportation modes, the flatrack was cabled to a flatcar to determine if it could be successfully transported this way.



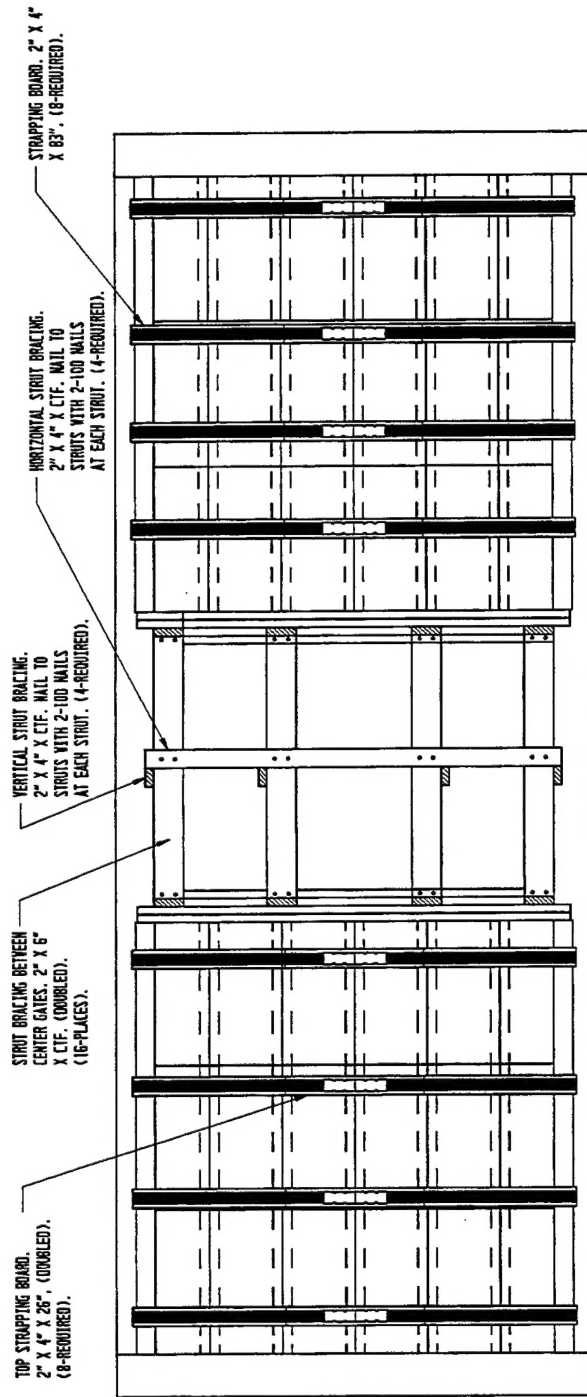
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Photo No. DAC-DEV-96-36-4. During rail impact tests, most loads have a tendency to slide in the direction of impact. This load compacted approximately 2 inches as a result of four impacts.

**PART 6**

**DRAWINGS**

# PLS FLATRACK (FS-2) WITH 155 MM PALLET TEST LOAD



TOP VIEW

